

CLAIMS

What is claimed is:

Claims 1-109 (cancelled)

- 5 110. (previously presented): A network having a plurality of multicast connections, said network comprising:

an input stage comprising r_1 input switches, and n_1 inlet links for each of said r_1 input switches;

- 10 an output stage comprising r_2 output switches, and n_2 outlet links for each of said r_2 output switches; and

- a middle stage comprising m middle switches, and each middle switch comprising at least one link (hereinafter "first internal link") connected to each input switch for a total of at least r_1 first internal links, each middle switch further comprising at least one link (hereinafter "second internal link") connected to each output switch for a
15 total of at least r_2 second internal links;

said network further is always capable of setting up said multicast connection by never changing path of an existing multicast connection, and the network is hereinafter "strictly nonblocking network", where m is a minimum of at least $2 * n_1 + n_2 - 1$.

- 20 111. (previously presented): The network of claim 110 wherein each multicast connection from an inlet link passes through at most two middle switches, and said multicast connection further passes to a plurality of outlet links from said at most two middle switches.

- 25 112. (previously presented): The network of claim 110 further comprising a controller coupled to each of said input, output and middle stages to set up said multicast connection.

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113. (previously presented): The network of claim 110 wherein said r_1 input switches and r_2 output switches are the same number of switches.

114. (previously presented): The network of claim 110 wherein said n_1 inlet links and n_2 outlet links are the same number of links and $n_1 = n_2 = n$, then m is a minimum of at least $3 * n - 1$.

115. (previously presented): The network of claim 110,
wherein each of said input switches, or each of said output switches, or each of said middle switches further recursively comprise one or more networks.

116. (previously presented): A method for setting up one or more multicast connections in a network having an input stage having $n_1 * r_1$ inlet links and r_1 input switches, an output stage having $n_2 * r_2$ outlet links and r_2 output switches, and a middle stage having m middle switches, where each middle switch is connected to each of said r_1 input switches through r_1 first internal links and each middle switch further comprising at least one link connected to at most d said output switches for a total of at least d second internal links, wherein $1 \leq d \leq r_2$, said method comprising:

receiving a multicast connection at said input stage;

fanning out said multicast connection in said input stage into at most two middle switches to set up said multicast connection to a plurality of output switches among said r_2 output switches, wherein said plurality of output switches are specified as destinations of said multicast connection, wherein first internal links from said input switch to said at most two middle switches and second internal links to said destinations from said at most two middle switches are available;

wherein said act of fanning out is performed without changing any existing connection to pass through another middle switch.

117. (previously presented): The method of claim 116 wherein said act of fanning out is performed recursively.

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118. (previously presented): A method for setting up one or more multicast connections in a network having an input stage having $n_1 * r_1$ inlet links and r_1 input switches, an output stage having $n_2 * r_2$ outlet links and r_2 output switches, and a middle stage having m middle switches, where each middle switch is connected to each of said r_1 input switches through r_1 first internal links and each middle switch further comprising at least one link connected to at most d said output switches for a total of at least d second internal links, wherein $1 \leq d \leq r_2$, said method comprising:
- checking if at least a first subset of destination output switches of said multicast connection have available second internal links to a first middle switch; and
 - 10 checking if a second middle switch has available second internal links to a second subset of destination output switches of said multicast connection.
- wherein each destination output switch of said multicast connection is one of said first subset of destination output switches and said second subset of destination output switches.
- 15 119. (previously presented): The method of claim 118 further comprising:
- checking if the input switch of said multicast connection has an available first internal link to said first middle switch and to said second middle switch.
120. (previously presented): The method of claim 118 further comprising:
- prior to said checkings, checking if all the destination output switches of said
 - 20 multicast connection are available at said first middle switch.
121. (previously presented): The method of claim 118 further comprising:
- repeating said checkings of available second internal links to another second subset of destination output switches for each middle switch other than said first and said second middle switches.
 - 25 wherein each destination output switch of said multicast connection is one of said first subset of destination output switches and said second subset of destination output switches.
122. (previously presented): The method of claim 118 further comprising:

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repeating said checkings of available second internal links to another first subset of destination output switches with each middle stage switch other than said first middle stage switch.

123. (previously presented): The method of claim 118 further comprising:

- 5 repeating said checkings of available first internal link to each middle stage switch other than said first middle switch and said second middle switch.

124. (previously presented): The method of claim 118 further comprising:

- setting up each of said multicast connection from its said input switch to its said output switches through not more than two middle switches, selected by said checkings,
10 by fanning out said multicast connection in its said input switch into not more than said two middle stage switches.

125. (previously presented): The method of claim 118 wherein any of said acts of checking and setting up are performed recursively.

126. (cancelled)

15 127. (cancelled)

128. (cancelled)

129. (cancelled)

130. (cancelled)

20 131. (previously presented): A network having a plurality of multicast connections, said network comprising:

 an input stage comprising r_1 input switches and n_1 inlet links for each of said r_1 input switches, and $N_1 = n_1 * r_1$;

 an output stage comprising r_2 output switches and n_2 outlet links for each of said r_2 output switches, and $N_2 = n_2 * r_2$; and

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a middle stage comprising m middle switches, and each middle switch comprising at least one link connected to each input switch for a total of at least r_1 first internal links; each middle switch further comprising at least one link connected to each output switch for a total of at least r_2 second internal links,

- 5 said network further is always capable of setting up said multicast connection by never changing path of an existing multicast connection, and the network is hereinafter “strictly nonblocking network”, where m is a minimum of at least $3 * n_1 + n_2 - 1$.

132. (previously presented): The network of claim 131 wherein each multicast connection from an inlet link passes through at most three middle switches, and said
10 multicast connection further passes to a plurality of outlet links from said at most three middle switches.

133. (previously presented): The network of claim 131 comprising a controller in communication with said input, output and middle stages to set up said multicast connection.

- 15 134. (previously presented): The network of claim 131 wherein said r_1 input switches and r_2 output switches are the same number of switches.

135. (previously presented): The network of claim 131 wherein said n_1 inlet links and n_2 outlet links are the same number of links and $n_1 = n_2 = n$, then m is a minimum of at least $4 * n - 1$.

- 20 136. (previously presented): The network of claim 131,
 wherein each of said input switches, or each of said output switches, or each of said middle switches further recursively comprise one or more networks.

137. (previously presented): A method for setting up one or more multicast connections in a network having an input stage having $n_1 * r_1$ inlet links and r_1 input switches, an
25 output stage having $n_2 * r_2$ outlet links and r_2 output switches, and a middle stage

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having m middle switches, where each middle switch is connected to each of said r_1 input switches through r_1 first internal links and each middle switch further comprising at least one link connected to at most d said output switches for a total of at least d second internal links, wherein $1 \leq d \leq r_2$, said method comprising :

5 receiving a multicast connection at said input stage;

fanning out said multicast connection in said input stage into at most three middle switches to set up said multicast connection to a plurality of output switches among said r_2 output switches of said multicast connection, wherein said plurality of output switches are specified as destinations of said multicast connection, wherein first internal links from
10 said input switch to said at most three middle switches and second internal links to said destinations from said at most three middle switches are available,

wherein said act of fanning out is performed without changing any existing connection to pass through another middle switch.

138. (previously presented): The method of claim 137 wherein said act of fanning out is
15 performed recursively.

139. (previously presented): A method for setting up one or more multicast connections in a network having an input stage having $n_1 * r_1$ inlet links and r_1 input switches, an output stage having $n_2 * r_2$ outlet links and r_2 output switches, and a middle stage having m middle switches, where each middle switch is connected to each of said r_1
20 input switches through r_1 first internal links and each middle switch further comprising at least one link connected to at most d said output switches for a total of at least d second internal links, wherein $1 \leq d \leq r_2$, said method comprising :

checking if all the destination output switches of said multicast connection have available second internal links from at most three middle switches.

25 140. (previously presented): The method of claim 139 further comprising:

checking if the input switch of said multicast connection has available first internal links to at most said three middle switches.

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141. (previously presented): The method of claim 139 further comprising:
repeating said checkings of available second internal links to all said destination output switches for all the other combinations of at most three middle switches.
142. (previously presented): The method of claim 139 further comprising:
5 repeating said checkings of available first internal links for all the other combinations of at most three middle switches.
143. (previously presented): The method of claim 139 further comprising:
setting up each of said connection from its said input switch to its said output switches through at most said three middle switches, selected by said checkings, by
10 fanning out said multicast connection in its said input switch into at most said three middle stage switches;
144. (previously presented): The method of claim 139 wherein any of said acts of checking and setting up are performed recursively.
145. (cancelled)
- 15 146. (cancelled)
147. (cancelled)
148. (cancelled)
149. (cancelled)
150. (previously presented): A network having a plurality of multicast connections, said
20 network comprising:
an input stage comprising r_1 input switches and n_1 inlet links for each of said r_1 input switches, and $N_1 = n_1 * r_1$;
an output stage comprising r_2 output switches and n_2 outlet links for each of said r_2 output switches, and $N_2 = n_2 * r_2$; and

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a middle stage comprising m middle switches, and each middle switch comprising at least one link connected to each input switch for a total of at least r_1 first internal links; each middle switch further comprising at least one link connected to each output switch for a total of at least r_2 second internal links, for $x \geq 1$,

- 5 said network further is always capable of setting up said connection by never changing path of a previously set up multicast connection, and the network is hereinafter “strictly nonblocking network”, where $m \geq x * n_1 + n_2 - 1$, for $x \geq 2$.

151. (previously presented): The network of claim 150 wherein each multicast connection from an inlet link passes through at most x middle switches, and said
10 multicast connection further passes to a plurality of outlet links from said at most x middle switches.

152. (previously presented): The network of claim 150 comprising a controller in communication with said input, output and middle stages to set up said multicast connection.

- 15 153. (previously presented): The network of claim 150 wherein said r_1 input switches and r_2 output switches are the same number of switches.

154. (previously presented): The network of claim 150 wherein said n_1 inlet links and n_2 outlet links are the same number of links and $n_1 = n_2 = n$, then $m \geq (x + 1) * n - 1$.

155. (previously presented): The network of claim 150,
20 wherein each of said input switches, or each of said output switches, or each of said middle switches further recursively comprise one or more networks.

156. (previously presented): A method for setting up one or more multicast connections in a network having an input stage having $n_1 * r_1$ inlet links and r_1 input switches, an output stage having $n_2 * r_2$ outlet links and r_2 output switches, and a middle stage
25 having m middle switches, where each middle switch is connected to each of said r_1

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input switches through r_1 first internal links and each middle switch further comprising at least one link connected to at most d said output switches for a total of at least d second internal links, wherein $1 \leq d \leq r_2$, for $x \geq 2$, said method comprising:

receiving a multicast connection at said input stage;

- 5 fanning out said multicast connection in said input stage into at most x middle switches to set up said multicast connection to a plurality of output switches among said r_2 output switches, wherein said plurality of output switches are specified as destinations of said multicast connection, wherein first internal links from said input switch to said at most x middle switches and second internal links to said destinations from said at most x middle switches are available,

wherein said act of fanning out is performed without changing any existing connection to pass through another middle switch.

157. (previously presented): The method of claim 156 wherein said act of fanning out is performed recursively.

- 15 158. (previously presented): A method for setting up one or more multicast connections in a network having an input stage having $n_1 * r_1$ inlet links and r_1 input switches, an output stage having $n_2 * r_2$ outlet links and r_2 output switches, and a middle stage having m middle switches, where each middle switch is connected to each of said r_1 input switches through r_1 first internal links and each of said r_2 said output switches through r_2 second internal links, for $x \geq 2$, said method comprising:

checking if all the destination output switches of said multicast connection have available second internal links from at most x middle switches.

159. (previously presented): The method of claim 158 further comprising:

- 25 checking if the input switch of said multicast connection has an available first internal links to said at most x middle switches.

160. (previously presented): The method of claim 158 further comprising:

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repeating said checkings of available second internal links to all said destination output switches for all the other combinations of at most x middle switches.

161. (previously presented): The method of claim 158 further comprising:

5 repeating said checkings of available first internal links for all the other combinations of at most x middle switches.

162. (previously presented): The method of claim 158 further comprising:

10 setting up each of said connection from its said input switch to its said output switches through at most x said middle switches, selected by said checkings, by fanning out said multicast connection in its said input switch into at most said x middle stage switches.

163. (previously presented): The method of claim 158 wherein any of said acts of checking and setting up are performed recursively.

164. (cancelled)

165. (cancelled)

15 166. (cancelled)

167. (cancelled)

168. (cancelled)

169. (previously presented): A network having a plurality of multicast connections, said network comprising:

20 an input stage comprising r_1 input switches and n_1 inlet links for each of said r_1 input switches, and $N_1 = n_1 * r_1$;

an output stage comprising r_2 output switches and n_2 outlet links for each of said r_2 output switches, and $N_2 = n_2 * r_2$; and

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a middle stage comprising m middle switches, and each middle switch comprising at least one link connected to each input switch for a total of at least r_1 first internal links; each middle switch further comprising at least one link connected to at most d said output switches for a total of at least d second internal links, wherein

5 $1 \leq d \leq r_2$,

wherein $m \geq \sum_{i=1}^p (x_i * a_i + n_1 - 1)$, where $\sum_{i=1}^p a_i = n_1 + n_2$ and $x_1, x_2, \dots, x_p \geq 1$;

wherein, for $1 \leq i \leq p$, multicast connections from a_i inlet links of each input switch pass through at most x_i middle switches,

said network further is capable of setting up said connection by never changing
10 path of a previously set up multicast connection, and the network is hereinafter "strictly nonblocking network", where $x_1, x_2, \dots, x_p \geq 2$.

170. (previously presented): The network of claim 169 comprising a controller in communication with said input, output and middle stages to set up said multicast connection.

15 171. (previously presented): The network of claim 169 wherein said r_1 input switches and r_2 output switches are the same number of switches.

172. (previously presented): The network of claim 169 wherein said n_1 inlet links and n_2 outlet links are the same number of links and $n_1 = n_2 = n$.

173. (previously presented): The network of claim 169,
20 wherein each of said input switches, or each of said output switches, or each of said middle switches further recursively comprise one or more networks.

174. (previously presented): A network having a plurality of multicast connections, said network comprising:

an input stage comprising r_1 input switches and n_1 inlet links for each of said r_1
25 input switches, and $N_1 = n_1 * r_1$;

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an output stage comprising r_2 output switches and n_2 outlet links for each of said r_2 output switches, and $N_2 = n_2 * r_2$; and

a middle stage comprising m middle switches, and each middle switch comprising at least one link connected to each input switch for a total of at least r_1 first
5 internal links; each middle switch further comprising at least one link connected to at most d said output switches for a total of at least d second internal links, wherein
10 $1 \leq d \leq r_2$,

said network further is always capable of setting up said connection by never changing path of a previously set up multicast connection, and the network is hereinafter
15 “strictly nonblocking network”, where m is a minimum of at least $2 * n_1 + n_2 - 1$.

175. (previously presented): The network of claim 174 wherein each multicast connection from an inlet link passes through at most one or two middle switches, and said multicast connection further passes a plurality of outlet links from said at most two middle switches.

15 176. (previously presented): The network of claim 174 comprising a controller in communication with said input, output and middle stages to set up said multicast connection.

177. (previously presented): The network of claim 174 wherein said r_1 input switches and r_2 output switches are the same number of switches.

20 178. (previously presented): The network of claim 174 wherein said n_1 inlet links and n_2 outlet links are the same number of links and $n_1 = n_2 = n$, then m is a minimum of at least $3 * n - 1$.

179. (previously presented): The network of claim 174,
wherein each of said input switches, or each of said output switches, or each of
25 said middle switches further recursively comprise one or more networks.

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180. (previously presented): A network having a plurality of multicast connections, said network comprising:
- an input stage comprising r_1 input switches and n_1 inlet links for each of said r_1 input switches, and $N_1 = n_1 * r_1$;
 - 5 an output stage comprising r_2 output switches and n_2 outlet links for each of said r_2 output switches, and $N_2 = n_2 * r_2$; and
 - a middle stage comprising m middle switches, and each middle switch comprising at least one link connected to each input switch for a total of at least r_1 first internal links; each middle switch further comprising at least one link connected to at
 - 10 most d said output switches for a total of at least d second internal links, wherein $1 \leq d \leq r_2$,
- said network further is always capable of setting up said connection by never changing path of a previously set up multicast connection, and the network is hereinafter “strictly nonblocking network”, where m is a minimum of at least $3 * n_1 + n_2 - 1$.
- 15 181. (previously presented): The network of claim 180 wherein each multicast connection from an inlet link passes through at most three middle switches, and said multicast connection further passes a plurality of outlet links from said at most three middle switches.
182. (previously presented): The network of claim 180 comprising a controller in
- 20 communication with said input, output and middle stages to set up said multicast connection.
183. (previously presented): The network of claim 180 wherein said r_1 input switches and r_2 output switches are the same number of switches.
184. (previously presented): The network of claim 180 wherein said n_1 inlet links and n_2
- 25 outlet links are the same number of links and $n_1 = n_2 = n$, then m is a minimum of at least $4 * n - 1$.

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185. (previously presented): The network of claim 180 ,
wherein each of said input switches, or each of said output switches, or each of
said middle switches further recursively comprise one or more networks.

186. (previously presented): A network having a plurality of multicast connections, said
5 network comprising:

an input stage comprising r_1 input switches and n_1 inlet links for each of said r_1
input switches, and $N_1 = n_1 * r_1$;

an output stage comprising r_2 output switches and n_2 outlet links for each of said
 r_2 output switches, and $N_2 = n_2 * r_2$; and

10 a middle stage comprising m middle switches, and each middle switch
comprising at least one link connected to each input switch for a total of at least r_1 first
internal links; each middle switch further comprising at least one link connected to at
most d output switches for a total of at least d second internal links, wherein $1 \leq d \leq r_2$,
for $2 \leq x \leq r_2$,

15 said network further is always capable of setting up said connection by never
changing path of a previously set up multicast connection, and the network is hereinafter
“strictly nonblocking network”, where $m \geq x * n_1 + n_2 - 1$.

187. (previously presented): The network of claim 186 wherein each multicast
connection from an inlet link passes through at most x middle switches, and said
20 multicast connection further passes a plurality of outlet links from said at most x middle
switches.

188. (previously presented): The network of claim 186 comprising a controller in
communication with said input, output and middle stages to set up said multicast
connection.

25 189. (previously presented): The network of claim 186 wherein said r_1 input switches
and r_2 output switches are the same number of switches.

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190. (previously presented): The network of claim 186 wherein said n_1 inlet links and n_2 outlet links are the same number of links and $n_1 = n_2 = n$, then $m \geq (x+1)*n$.

191. (previously presented): The network of claim 186,
wherein each of said input switches, or each of said output switches, or each of
5 said middle switches further recursively comprise one or more networks.

192. (previously presented): A network comprising a plurality of input subnetworks, a plurality of middle subnetworks, and a plurality of output subnetworks, wherein at least one of said input subnetworks, said middle subnetworks and said output subnetworks recursively comprise:

10 an input stage comprising r_1 input switches and n_1 inlet links for each of said r_1 input switches;

an output stage comprising r_2 output switches and n_2 outlet links for each of said r_2 output switches; and

a middle stage, said middle stage comprising m middle switches, and each middle
15 switch comprising at least one link (hereinafter "first internal link") connected to each input switch for a total of at least r_1 first internal links, each middle switch further comprising at least one link (hereinafter "second internal link") connected to at most d said output switches for a total of at least d second internal links, wherein $1 \leq d \leq r_2$, and for $x \leq 2$;

20 wherein each multicast connection from an inlet link passes through at most x middle switches, and said multicast connection further passes to a plurality of outlet links from said at most x middle switches.

193. (new): A method of setting up a multicast connection through a three-stage network, said multicast connection comprising a plurality of output switches having destination
25 outlet links, said method comprising:

fanning out only one or two times in an initial stage,

and fanning out any number of times in each of the remaining stages,

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wherein said three-stage network includes said remaining stages and said initial stage.

194. (new): The method of claim 193 further comprising:
repeating said acts of fanning out with a plurality of portions of each of said
5 stages.

195. (new): The method of claim 193 further comprising:
recursively performing said act of fanning out.

196. (new): The method of claim 193 wherein:
a remaining stage immediately following said initial stage comprises internal links
10 that are at least two times the total number of inlet links of said initial stage.

197. (new): The method of claim 193 wherein:
said initial stage comprises a plurality of first switches, and a plurality of inlet
links connected to each said first switch; and
a remaining stage immediately following said initial stage comprises a plurality of
15 second switches, that are at least double the number of inlet links of each first switch and
each second switch comprises a plurality of internal links at least equal in number to the
number of first switches in said initial stage.

198. (new): A method of setting up a multicast connection through a three-stage network,
said multicast connection comprising a plurality of output switches having destination
20 outlet links, said method comprising:
fanning out at most three times in an initial stage,
and fanning out any number of times in each of the remaining stages,
wherein said three-stage network includes said remaining stages and said initial
stage.

199. (new): The method of claim 198 further comprising:
repeating said acts of fanning out with a plurality of portions of each said stages.

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200. (new): The method of claim 198 further comprising:
recursively performing said act of fanning out.
201. (new): The method of claim 198 wherein:
a remaining stage immediately following said initial stage comprises internal links
5 that are at least three times the total number of inlet links of said initial stage.
202. (new): The method of claim 198 wherein:
said initial stage comprises a plurality of first switches, and plurality of inlet links
connected to each said first switch; and
a remaining stage immediately following said initial stage comprises a plurality of
10 second switches, that are at least three times the number of inlet links of each first switch
and each second switch comprises a plurality of first internal links at least equal in
number to the number of first switches in said initial stage.
said multicast connections having a fan-out of one or more in said middle stage.
203. (new): A method of setting up a multicast connection through a three-stage network,
15 for $x \geq 2$, said multicast connection comprising a plurality of output switches having
destination outlet links, said method comprising:
fanning out at most x times in an initial stage,
and fanning out any number of times in each of the remaining stages,
wherein said three-stage network includes said remaining stages and said initial
20 stage.
204. (new): The method of claim 203 further comprising:
repeating said acts of fanning out with a plurality of portions of each of said
stages.
205. (new): The method of claim 203 further comprising:
25 recursively performing said act of fanning out.
206. (new): The method of claim 203 wherein:

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a remaining stage immediately following said initial stage comprises internal links that are at least x times the total number of inlet links of said initial stage.

207. (new): The method of claim 203 wherein:

5 said initial stage comprises a plurality of first switches, and plurality of inlet links connected to each said first switch; and

 a remaining stage immediately following said initial stage comprises a plurality of second switches that are at least x times the number of inlet links of each first switch and each second switch comprises a plurality of first internal links at least equal in number to the number of first switches in said initial stage.

10